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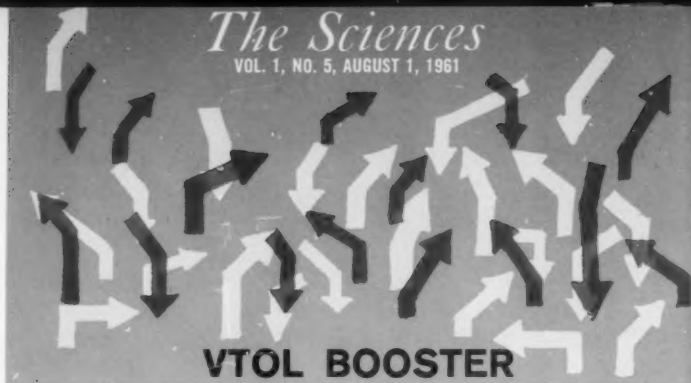


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THE CREATION of a hole in the exhaust tubes of conventional jet engines produces an "ejector effect" which increases the thrust of the engine while reducing fuel consumption, noise level, and jet temperature.

The ejector-effect principle was described in a paper comparing the five basic types of Vertical Takeoff and Landing aircraft (VTOL) presented before The Academy by I. B. Laskowitz. (The paper was chosen for the D. B. Steinman Award in Structural Engineering).

A VTOL aircraft is defined "... as one that takes off vertically, changes from hovering to forward flight, cruises to its destination, resumes hovering flight, and then performs a vertical landing." They may be driven by rotor, propeller, ducted fan, turbojet or other gas producer, and rocket (in the order of ascending speed capability).

A rotor serves to lift a helicopter as well as furnish it with forward flight capabilities. It also provides "... the important safety feature of autorotational descent of the craft in an emergency, as in engine failure." But rotors are costly and contribute to the weight and complexity of the aircraft. Their elimination is therefore desirable, if the provision for emergency can be engineered into multiple turbojet engines or other mechanisms having a high power or thrust-to-weight ratio. To eliminate the need for complex ground gear, it is also a prime necessity for direct-lift aircraft to possess the ability to take off and land in a horizontal position.

In order to provide an inherent stability to the aircraft by means of a freely suspended vertical exhaust nozzle, the lift thrust must be concentrated above the center of gravity of the aircraft.

The "ejector effect" is utilized to augment the thrust of a turbojet engine mounted in a VTOL aircraft. This entails the creation of two openings on the side of the exhaust tube, thus permitting air to be

sucked in and mixed with the gas jets. The vertical and horizontal thrust of the engine is increased. This principle in no way hampers the simplicity of the basic jet engine, in that it does not require additional rotating as in the turbofan or lift fan engine.

The exhaust from a turbojet engine, mounted upon a rotorless VTOL aircraft, may be directed vertically or horizontally by means of a rotary control valve. The vertical exhaust nozzle is mounted on a ball-bearing gimbal, allowing it to be tilted to vary the direction of the lift thrust, longitudinally or transversely. This movement is regulated by means of a control stick attached to the ends of the gimbal. Aileron and elevator control, for forward flight, is also operated by the control stick. Jet-steering control for hovering and vertical flight depends upon compressed-air bleed valves operated by foot pedals, as does the rudder for steering in forward flight. In addition the control stick operates jets for maintaining lateral and longitudinal stability. The various controlling forces are so linked by means of the stick and pedals that they serve to supplement one another for better stability and control of the aircraft.

Another important aspect of the new concept in VTOL Aircraft is that the exhaust nozzle tends to assume a vertical position by the action of gravity whether gas is discharged through it or not: "... in forward flight with hands off the control stick, the nozzle moves freely with the control stick to effect the aileron and elevator forces that produce stabilizing moments when the aircraft is inclined either laterally or longitudinally and that give the aircraft inherent stability in forward flight. Thus the freely suspended exhaust nozzle furnishes a 'mechanical means' to provide inherent stability to the aircraft under all flight conditions." The operation of the aircraft in high-speed forward flight is the same as a conventional one.

A scale prototype model of an 1800-lb. VTOL was constructed to determine the numerical value of the ejector effect and ground effect (a ratio between the diameter of the exhaust opening and its height above ground level, to determine the maximum thrust).

It was found that the performance characteristics (thrust, endurance, range and fuel consumption) with the basic turbojet increased 2.0 to 2.5 times with the ejector effect augmentation. In addition there was a reduction in fuel consumption, and a much smaller engine could be utilized to achieve a given thrust.

A performance comparison of the General Electric J85 turbojet and CF700-1 turbofan engine was made. The tailcone of the turbojet was replaced by a fan assembly consisting of a single-stage, free-

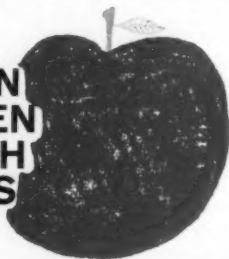
floating turbine, with tip-mounted compression blading and concentric jet nozzles. The fan is driven by the engine exhaust gases and thus compresses a secondary flow of air.

The indications were that "... the turbojet engine with ejector effect is preferred because of better performance and fewer rotating parts."

Mr. Laskowitz concluded that the new concept of VTOL shows "... considerable promise and potential for wide-spread and commercial application."

In the rest of the aircraft industry, research proceeds on the development of an economical VTOL. Perhaps the most novel approach is the tilt-wing craft, with wings in the horizontal position for normal flight, switching toward vertical for takeoffs and landings. Test models are now flying. The British are using a combination helicopter and airplane, with jets mounted on the tips of the rotor blades for power. The rotor is powered only during takeoff and landing; it supplies lift during level flight by rotating freely. Stubby wings and conventional engines and propellers supply further lift and forward speed. Some of these ideas may be used in combination.

THE GARDEN OF EDEN AND MYTH ANALYSIS



THE MORAL and ethical functions of myth in a given society are interpreted by symbolist thinkers to serve two primary purposes: Myth "explains the inexplicable," e.g., the origin of the world, death, etc.; myth attempts to soften the harsher realities of life by manipulating symbols of them. The symbolists view myth as an entity in itself; its interpretation requires no reference to the social context in which it occurs, according to a paper presented before The Academy's Division of Anthropology by Professor Edmund Leach of The Center for Advanced Study in The Behavioral Sciences, Stanford University. Leading writers he associated with this school were James G. Frazer, Sigmund Freud, and the early Ernst Cassirer.

An opposing position is maintained by the functionalists, repre-

sented by Emile Durkheim, Jane Harrison, B. Malinowski and Cassirer in his later writings. The functionalists believe myth to have an intimate and direct association with the social context in which they appear. Malinowski stated the functionalist case when he described myth as providing "... a justification for the facts in a present day social situation." A myth in its social framework may have the force of a legal precedent in a court of law.

The functionalists are disinterested in writings of sophisticated religions in that they are "divorced from their ritual context."

Professor Leach quoted C. Lévi-Strauss as repudiating the functionalist theory, which he characterized (1956) as assuming "that myth and rite are homologous ... the myth and the rite reproduce each other, the one at the level of action, the other at the level of ideas." Instead, Lévi-Strauss would substitute a revised form of symbolist analysis which he termed "structural." This consists of collecting and analyzing all variant forms of a myth to discover a common idea that gives it meaning and importance. Through such study, the pattern of the various elements can be identified and related statistically. "Lévi-Strauss denies the existence of any causal link by which myth overtly justifies the patterning of social action or vice versa," although both myth and rite in a given culture "may share a common structure," Professor Leach said. This means that when the elements of a myth and an associated rite are regarded as elements of a logical statement, they may appear to say the same thing. Despite this, each is independent and may be so studied, Lévi-Strauss believes.

The Lévi-Strauss contention, according to Professor Leach, is that the most rewarding approach to myth is to assemble and analyze the variant forms in order to discover the "fundamental essence" that will recur throughout all such variants and reveal its common structural composition — that which gives it meaning. Fundamentally, acceptance of myth as a phenomenon which provides a "logical model by means of which the human mind can evade unwelcome contradictions, such as that human beings cannot enjoy life without suffering death or that rules of incest (which specify that legitimate sex relations can only be between members of opposed kin groups) conflict with a doctrine of unilineal descent." Myth has the function of interpreting such contradictions in a way that renders them less final and more acceptable. This is accomplished not by a single myth but by "clusters of myths that are similar in some ways but different in others so that, in accumulation, they tend to blur the edges of real (but unwelcome) category distinctions."

Professor Leach believes that the Lévi-Strauss thesis suffers weaknesses, some of which are "a good deal more damaging than the alleged weaknesses of functionalism. Nevertheless, he has made out a case. At the very least he has demonstrated that the functionalist thesis, in its more orthodox form, is unnecessarily inhibiting. He has reopened what had begun to look like a closed argument."

Professor Leach tested the three theories "against the basic myth of our own society" — the story of the creation as recorded in Genesis. The symbolists, he noted, favor only one of the stories of creation . . . the Garden of Eden. Frazer and Freud agree that the core of the story is that of Eve, the serpent and the forbidden fruit, thus providing "an elementary example of the use of phallic symbolism." Frazer further observed that the Tree of Knowledge of Good and Evil from which the apple came is identified as the Tree of Life, and stands in opposition to the Tree of Death. Also, Adam and Eve were not, in the first instance, forbidden to eat of the Tree of Life, as they were of the Tree of Death.

The functionalists see in the seven-day creation "a mythical charter for the seven-day week," as well as one for the Jewish taboos. All living things were assigned to specific categories: fowls of the air, cattle, beasts, crawling things, and fish. Any creature that broke out of this category, such as water creatures without fins or animals and birds that eat meat, would be considered "abominations" as classified in Leviticus 11, according to Mary Douglas (1959), Professor Leach showed.

"The functionalist treatment of the material leads to an orthodox thesis . . . concerning taboo, sacredness and abnormality." The Garden of Eden story has little appeal for the functionalist, "thus neither the symbolist nor the functionalist approaches can be considered adequate. Each tells us something but neither offers an answer to the total question: What is Genesis 1 to 4 about?"

Application of the Lévi-Strauss method of analysis, however, gives Genesis new shape, a "shape that recurs in both parts of the story and is repeated again in a third form of the Cain and Abel story that follows."

Every category has one of opposition, followed by a "mediating" category. "Fresh water above (fertile rain) is opposed to (salt) water below (sea). Mediated by firmament (sky)." Male and female are a simultaneous creation (Gen. 1: 1-5). In the story of the Garden of Eden the same oppositional categories exist but are mediated by a fertilizing mist drawn up out of the infertile earth. Adam is created

from the dust, as are animals. Dry lands are fertilized by a river that springs from the ground of Eden. A fertile Eve is created from the rib of infertile Adam. After eating the fruit of the Tree of Knowledge of Good and Evil, Adam and Eve become aware of sexual differences, "death becomes inevitable (Genesis 3, vv. 3 to 8)" and "... pregnancy and life become possible."

The Lévi-Strauss theory, when applied to the Cain and Abel story, shows that the opposition between the gardener and the herdsman "is the same opposition as that between the first three days of the creation and the last three days, the static world versus the living."

Professor Leach does not maintain that this is the only legitimate analysis, but "it surely throws some new light on the mysterious workings of what Durkheim used to call the 'collective conscience.'"



MONTÉ CARLO METHODS

TO THE NONINITIATES, mathematics is an esoteric world replete with mysteries of an unknown nature. For the mathematically sophisticated, the world is no less mysterious — but they have the advantage of knowing the precise nature of the puzzles. Most persons consider, for instance, that experimental science has reached a degree of precision when it becomes amenable to mathematical analysis. But few outside of the cognoscente realize that the test of a mathematical system's consistency is the ability to translate it into some physical system (or into some other mathematical system that can be so translated). Some mathematical areas, which are usually assumed to be completely deductive, are studied by purely experimental methods.

One of those experimental systems in mathematics is known as "Monte Carlo methods." J. M. Hammersley spoke on these methods at the Academy conference on Numerical Properties of Functions of More than One Independent Variable. "In Monte Carlo work," he stated "the raw observational data are a set of random numbers; the way in which they are handled computationally, to yield some desired

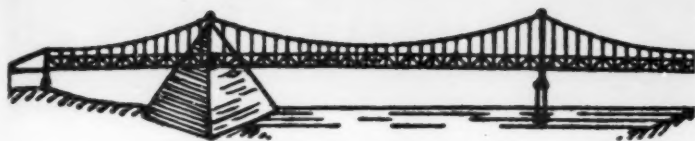
result, constitutes the experimental technique. As in a physical experiment the observed data, and hence the results, are subject to experimental error. The better the experimental technique, the smaller are the consequent errors in the final results. The real art of Monte Carlo work is to obtain an acceptably small error in these results without expending inordinately great labor upon their production."

As an example of the use of these methods, Hammersley indicates that some problem may involve the solution of, say, Laplace's partial differential equation; but depending on the conditions this may not be amenable to solution. Certain probability functions, however, are known to approximate the Laplace equation when large numbers of elements are involved. The probability conditions are made to coincide with the conditions of the original problem, and then random elements are studied by computer. The better the random elements are chosen, the closer the solution of the probability problem will be to the original. Thus a purely mathematical problem is solved (within limits) by an experimental approach.

Hammersley's primary concern was with the study of Monte Carlo methods when more than one variable is involved. A special kind of problem is formed that is largely unfamiliar to even those persons with a fairly extensive mathematical background. This may be due, as Henry C. Thacher, Jr., indicated in the conference's introductory remarks, to the fact that "In undergraduate mathematics courses, it is frequently implied that the multivariable case is a rather trivial extension of the single variable problem that is being studied in considerable detail. This is not the case." A polynomial of degree n in a single variable has n roots, but "a polynomial of degree n in two variables has an infinity of roots."

COMPUTER APPLICATIONS

Since the advent of computers, many numerical analysts have entered the field from the physical sciences and engineering, and much of the very abstract work of pure mathematicians in multivariable analysis is not available to them. One of the purposes of the meeting was to present some of the newer material in workable form. In keeping with that purpose, the papers delivered included discussions of the derivation of interpolation formulas, methods of fitting empirical data, and solutions of nonlinear equations — all when more than one variable is involved.



BUILDERS—PAST & PRESENT

GUIDED BY 85,000 blueprints, 10,000 men worked for nearly three years to build the 26,000 feet of Mackinac Bridge across the Mackinac Straits. Completed, its 3,800-foot center suspension hangs in the air 155 feet above the confluence of Lakes Huron and Michigan from 550-foot-high steel towers mounted on 300,000-ton concrete pillars which in turn are embedded in solid rock 250 feet below the water's surface.

A million tons of concrete below the water supports another million tons above it and the five million rivets and one million bolts that hold the steel roadway together. The bridge is a further testament to man's capacity to construct, to combine gigantic proportions with beauty and utility to delight the senses and advance commerce.

This innate constructive capacity, the fundament of man's existence and growth, will be juxtaposed from two of the greatest periods of human history with the construction of the Aswan High Dam. In fact, as a by-product of the dam's construction, modern man will cut loose, package and remove to a higher site a group of the great protuberant graves that represented ancient Egypt's highest engineering development, and have for centuries been regarded with awe.

Sadd-el-Aali, now being built at Aswan, will hold back 104 million acre-feet of Nile water. Some 50 million cubic yards of aggregates will form the substance of the dam, or more than 16 times the volume of Khufu's Great Pyramid. The deepest segments of the grout curtain will be sunk nearly 700 feet and bonded to natural bedrock. The base of the dam will be 3,300 feet thick. The diversion canal will pass 400,000 cubic feet of water per second via a special spillway designed to protect the river bed at the down side; in cross section, the canal will be the largest in the world. Six thousand men will work until 1970 to complete the dam. Sadd-el-Aali will provide 2.1 billion watts of power, irrigate 1.7 million acres of Egypt, and triple the arable land of the Sudan.

By such works, modern man is changing the facts of the earth, altering the lives and future histories of entire civilizations.

...in brief....

Great Britain's Atomic Energy Authority possesses the world's largest supply of protactinium — 125 gm of 99.9% pure Pa^{231} . Protactinium occurs with natural uranium in the concentration of 0.34 p.p.m. (parts per million); in the rich source of uranium, pitchblende, the concentration is 0.10 p.p.m. Recovery, separation, and purification were carried out at Springfields, Windscale, and Harwell, three British AEA stations.

Collection work began with an ether sludge from an extraction procedure with Congo pitchblende ores which has 3.0 p.p.m. Pa concentration. From some 60 metric tons of the exceeding rich ores, about 12 metric tons of uranium were extracted, and about 150 gm protactinium. The 12-stage extraction process has now been made public by the British AEA. The cost: about half a million dollars. Similar, but slightly different, methods were used by the three stations. The available product will be distributed to universities throughout the world for the study of protactinium chemistry.

British AEA people expect this 125-gm single supply to stand as the biggest load of Pa for a long time to come. Uranium ores are growing scarce now; the residues from U-poor ores, for which efficient U extraction techniques have had to be developed, do not yield Pa fractions except at prohibitive cost.

In the process of nucleon-antinucleon annihilation, high-energy gamma rays are produced. The detection and measurement of these rays bears on questions such as galaxy-antigalaxy collisions and cosmologic theories that postulate the creation of matter and antimatter.

Thomas L. Cline recently used a balloon-borne high-energy gamma ray detector in an attempt to determine the upper limits of the creation rate and density of interstellar antinucleons. Now at the National Aeronautics and Space Administration's Goddard Space Flight Center, Cline did this work while at the Laboratory for Nuclear Science of the Massachusetts Institute of Technology.

In a report published in "Physical Review Letters," Cline points out that the steady-state theory requires that protons be added to

the universe at the rate of 3×10^{-22} per cm^3 per second. (This would be just enough to maintain the average density of matter in an expanding universe. According to the rival "big-bang" evolutionary theory, the expansion takes place without this creation of matter, so that the density constantly decreases. To date, all experiments designed to determine the correctness of one or the other theory have been inconclusive.)

Cline found that the upper limit for antiproton production or annihilation, which should be the same for protons, is 2.5×10^{-23} per cm^3 per second, which is less than the steady-state requirement by a factor of approximately 10. This does not necessarily contradict the steady-state theory, however, since the necessary proton-production rate is calculated from the experimental determination of the average density of the universe. This has been taken to be 10^{-28} to 10^{-29} gm per cm^3 , but the uncertainty of these figures may be as much as 10^3 less than that given. A correction of the density determination would perhaps permit the upper limits of proton-production rates to fit the steady-state theory.

The profusion of different kinds of subatomic particles is one of the major problems of modern physics. From a pleasantly simple system of electrons, protons and neutrons, the microcosmic world has grown to over 30 different varieties. One of the tasks of theoretical physicists is to explain this number, but in order to do so they need more information about the interactions of particles, their masses, lifetimes, and so forth.

In an attempt to obtain some of that information, R. G. Glasser, N. Seeman and B. Stiller, of the Nucleonics Division, Naval Research Laboratory, recalculated the lifetime of the neutral pi meson (pion). Using the time-of-flight technique, and aided by a new, high-resolution photographic emulsion, the investigators obtained $1.9 \pm 0.5 \times 10^{-16}$ seconds for the interval from the pion's coming into existence until its decay into two photons.

Both in Great Britain and the United States, aircraft corporations are currently investigating the best design of "laminar flow" aircraft wings. If the researches are successful — and it appears at this stage that they will be — aircraft will be able to either double their current payload or increase their range substantially.

The laminar-flow wing is intended to offset the boundary layer of air that develops at the surface of the airfoil and results in turbulence and drag. This substantially decreases the aircraft's performance. Holes or slots in the wing of the airplane, however, would act like vacuum cleaners and suck the turbulent boundary layer into and through the wing. The laminar-flow wings are expected to bring significant reductions in air transport costs, while improving the characteristics of aircraft performance.

Egyptian records dating from the 6th Dynasty place the BaMbuti pygmies in their present region of the Ituri Forest in the Congo. The cultural integrity these forest dwellers have maintained for more than 4,000 years may now be coming to an end as a result of the changes taking place throughout Africa.

Colin Turnbull, of the American Museum of Natural History, writes that the BaMbuti have virtually no visual art, but that their music is the most complex in all of Africa. "It is complex not only in terms of rhythm, melody, and harmony (the latter surprisingly enough in Africa), but also in terms of technique. The BaMbuti can improvise a 15-part liturgy or canon, with melodies frequently running in parallel seconds, and hold it without the slightest difficulty."

The sense of hearing is more important to these people than to most other groups. They use vision to follow game tracks, but in their restricted forest world, where sight is limited to about 100 feet, they will frequently aim their arrows by sound alone. They have no names for colors other than black, white and red. All other colors are designated by comparison with objects such as leaves or animals.

The BaMbuti can count only up to four, but they have a well-developed sense of pattern. In one of their games, played with beans or pebbles, a player can tell at a glance whether as many as 40 beans form a multiple of four or not, or how many must be added to make the total a multiple of four.

One young pygmy taken on a trip by Turnbull did not know what mountains were when he saw them for the first time. Animals seen at a great distance were thought to be insects, and the pygmy believed it witchcraft that made them grow larger as they rode closer to them by car. The pygmies are unable to correlate great distance and small size.

Writing in the *American Journal of Psychology*, Turnbull states that the pygmies are aware that their way of life may be coming to

an end. Some believe that "when the forest is no more we shall die," but the majority accept that "we shall have to live like the savages [sic] and plant bananas."

The peak power emitted in the explosion of a Type II supernova is of the order of 10^{34} watts. A Type I will release 10^{35} , which is equivalent to the total power output from a galaxy of 100,000,000,000 stars.

C. M. Cade, writing in *Discovery*, calculates that a supernova going off in the near reaches of this galaxy would wreck communication systems on earth. Short-wave would be more or less affected, depending on frequency. Ordinary AM radio would not be changed drastically, but television would be obliterated. Early-warning radar would be useless, and standard aircraft and marine radar navigation would be ruined. The effect would last for months.

The extent to which the government supports the electronics industry in the United States is suggested by findings from a survey conducted with the cooperation of the Department of Defense by the Electronics Industries Association.

The study showed that of some 155,000 engineers and scientists engaged in electronics work, approximately 76 per cent are supported by government funds. Of the total in the field, 83 per cent are in industry, eight per cent are employed by government, and five per cent are engaged in research for universities or nonprofit organizations.

The importance of the tachometer as a component of an increasingly large variety of control systems has led to the development of a new diode type which may prove superior to existing forms of the instrument.

W. H. Middendorf and F. C. Weimer have constructed a pilot model of the diode tachometer which is rated as follows: low inertia, low friction, no residual output at zero speed, and a d.c. voltage output precisely proportional to speed. The unit consists of two electrodes and an insulated rotor. The electrodes, or "combs," are made up of two rows of steel needles — 58 in all.

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